International Journal on Advanced Science Engineering Information Technology

Vol.9 (2019) No. 1
ISSN: 2088-5334

Requirements Engineering (RE) Process for The Adaptation of The Hospital Information System (HIS)

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***Abstract*— Requirements Engineering (RE) process is an initial stage for any software development process. In this research, we adopted the RE process into a system adaptation software project for a Hospital Information System (HIS) in a Saudi Arabian hospital. Instead of developing from scratch, the adaptation of an existing system enables a working system to be configured into use in a similar situation in another organization, or use it in a different organization in a different geographical area. Nonetheless, the approach of systems adaptation has its own issues and challenges. This research considers investigating culture-specific behaviors when adapting a system to another environment. The research is motivated by the challenges faced by real-life cases of implementation of a HIS developed in South Korea at one of Kingdom of Saudi Arabian (KSA) hospital. The cultural behavioral requirements were identified using focus group technique and the outcomes were analyzed and represented using Unified Modelling Language (UML). The outcome of the research is validated through evaluation of feedback from a review session and academic experts. This work investigates cultural and behavioral features that have the potentials to support software engineers, who are considering new systematic techniques and approaches to improve systems adaptation processes, especially in HIS domain. This work could be used as a reference to guide developers to adapt similar systems in similar culture and environment settings. In addition to an adaptation to a specific environment, the outcome could also be useful for designing system for-reuse facet from the perspective of reusability.**

***Keywords*— Hospital Information System adaptation; system adaptation; requirements engineering; cultural-specific behaviors; software adaption.**

I. INTRODUCTION

HIS is an automated system used to manage the sector of health care. Patient records, prescriptions, and imaging data are all managed through the system. Imaging data can be provided from Computed Tomography (CTs) and Magnetic Resonance Imaging (MRIs) imaging devices which are also connected to the HIS. Furthermore, the system manages admission and discharge patients' records, health care staff, administrative records, treatment charges, equipment, and medical devices.

HIS is expected to reduce cost through efficient, cost-effective and safety of medical deliveries [2], [3]. Riyadh hospitals need HIS to manage their patients efficiently and conveniently. Since Saudi Arabia's market lack HIS availability, the hospital's management decided to adopt an existing HIS developed by a South Korean developer (No reference could be provided due to non-disclosure agreement). The idea of adopting and adapting the SK system helps to save cost, time and effort. Nonetheless, it has drawback i.e. the system is developed based on requirements to suit SK needs and constraints. However, some of those needs and constraints do not apply to Riyadh Hospitals due to their culture and norms.

These issues had motivated the research to investigate any needs for the HIS to be implemented in the Saudi Arabia hospitals. This paper is part of the work [1], [4]; however, the paper is focusing more on a case study of the SK HIS adaptation to the Kingdom of Saudi Arabia (KSA) HIS from the perspective of user interface adaptation [4].

This paper presents parts of work from the perspective of the RE process. In this process, the cultural, behavioral requirements were identified using requirements elicitation techniques that is focus group technique; outcomes were

analyzed and represented using the Unified Modelling Language (UML). Finally, the analyzed requirements were validated in a required review session.

This research considers the issues with an adaptation of the HIS to a different cultural environment, i.e. KSA. The problems the research explores is the adaptation of including cultural features into the systems transformation and requirements – which is needed to be addressed as a part of HIS adaptation. The research identifies and defines the culture and environmental characteristics that have the potential to help software engineers explore techniques and approaches to improve system adaptation processes, particularly in the HIS field. The term culture is defined as "a collective phenomenon, which is shared with people who live or lived within the same social environment." It is also defined by [5] as "(i) Culture consists of the unwritten rules of the social game, and (ii) Collective programming of the mind that separates the members of one group or category of people from others."

The following research questions are formulated to examine a solution to the above-defined research problem of HIS adaptation:

- Q1- What are the cultural behavior issues that influence HIS adaptation for the KSA environment?
- Q2- How those issues could be mapped towards implementing HIS application specific that suits the KSA environment?

The scope of this research covers four main modules in HIS that are 1) User Management Module, (2) Electronic Medical Record (EMR) Module, (3) Nutrition Module, and (4) Patient Services Module. In addition to that, the scope of work that will be reported in this paper is only on the Requirements Engineering (RE) phase, which is the early phase of the research.

This work investigates cultural and environmental features that have the potentials to support software engineers considering new systematic techniques and approaches to improve systems adaptation processes, especially in HIS domain. The outcomes of this work could be used as a reference to guide developers for adopting similar systems for KSA or similar culture and environment setting. In addition to an adaptation to a specific environment, the outcome could also be useful for designing system for-reuse facet from the perspective of reusability.

The remainder of the paper is structured as follows: Section II provides the background of HIS adaptation and adaptation technique to introduce the context. The following sections elaborate the research methodology for the RE work, discussion and finally, the conclusion.

II. Material and Method

This section introduces (1) research background, which covers adaptation techniques, HIS adaptation, its related work and (2) our method.

A. Adaptation Techniques

Although it has been a common and realistic practice to buy a system from a developer and configure it to an organization's purpose in different geographical areas, software systems adaptation still has received little attention in scientific research [6]. Adapting a successful system is preferred than building a new system all over – an approach that was found successful throughout many organizations. Referred to as buying a third-party software systems or commercial-off-the-shelf (COTS) product, this approach configures the software according to different situations that require the functionalities and services supported by such a system closely [7]. From a software engineering perspective, the development of the COTS product is performed during the for-reuse stage, while reusing the COTS for deployment is done during the with-reuse stage. Obviously, adaptation fits into the with-reuse stage where some modification is required in order to reuse the existing components or software systems.

The software development life cycle of a software system potentially takes a long cycle, and the development team (requirement engineers, designers and software developers) needs to figure out the system components before delivery. However, it is almost impossible to accurately anticipate the requirements of all potential users and customers making it impossible to have a single best or optimal system configuration that best suits in all settings. The active involvement of users and a clear understanding of the requirements of users and tasks are difficult enough to develop software systems. It is even more challenging when adapting software systems to a particular situation or functionality because (1) potential user groups and customers are unknown from the outset; (2) requirements need to be identified according to unknown future scenarios, and (3) potential user groups need to be revised as ideas develop because different user groups may be affected [6].

Potential requirements and modifications are impossible to anticipate from the developer's perspective. Hence, when a system is developed without a specific target environment in mind, an adaptation is required to ensure the system fits the new environment. Kell [8] defines adaptation as "any process, which modifies or extends the implementation or behavior of a subsystem to enable or improve its interactions, or synonymously, its communication with the surrounding parts of the system." The adaptation of the software system is the process of transferring an old, legacy system to a new system by introducing similar functions for the system [9]. In this research context, the adaptation refers to the system customization by adapting the functionalities based on the new operational environment of the systems.

The variance and research process tradition have both studied systems adaptations. However, neither has offered a satisfying explanation of the phenomenon. Furthermore, a unified model is needed for disconnected evidence. As detailed by Beaudry and Pinsonneault [10], major studies dealing with the IS adaptation to users have defined user adaptation at an individual level through various concepts such as adjustment [11], adaptation [12], [13], appropriation [14], mutual adaptation [15] and reinvention [16], [17]. The Coping Model of User Adaptation (CMUA) [10] is an attempt to consider possible complementarity factors between variance and process approaches. Newman and Robey [18] suggested that each approach should cater for (1) factor research - where it establishes strong empirical connections between antecedent conditions and later outcomes; (2) process research – where it examines the streams of activities that explain these connections [19].

Researchers suggested not to combine variance and process approaches in a single model even after consideration. Each approaches' value was recognized by researchers, depending on the research purpose. Within the context of system adaptation studies, few have attempted to reconcile the two approaches, even though they can merge the approaches. However, as several authors have suggested, this could perhaps help to create richer models as a risky attempt [10], [20], [21]. From this attempt, CMUA took an important step towards explaining the adaptation of systems and users to IT. In fact, given the results of both the variance and the research process tradition, CMUA is probably a major step towards a unified view of user adaptation. First, they try to solve the variance and processing of research traditions, which facilitates the opening of the black box for the use of the system, thus taking advantage of the rich material provided by both traditions. Second, CMUA sets out a user-centered perspective and encourages researchers to concentrate on agency behaviors [10].

In addition to the separate evolution of variance and process traditions, research has identified multiple fragmentary approaches to IS usage [22]. These approaches, together, make the research stream confusing. For example, user adaptation research can be found in the user acceptance and usage stream. Many demand alternative models to investigate the related phenomenon about the highly successful adoption of the Technology Acceptance Model (TAM).

According to Bagozzi [22], for instance, the IS field risks being overwhelmed, confused and misled by the growing piecemeal evidence behind the decision- making and technology adoption/acceptance/rejection actions. What is needed is a unified theory of how the many divisions of knowledge are consistent and explain decision- making [22]. It is suggested to study user adaptation via CMUA as an attempt to respond to these concerns. Beaudry and Pinsonneault [10] define the process of adaptation as a "one-sided copying process." They believe that "coping with the adaptation acts performed by an individual in response to disruptive events in his or her environment" [10].

By the Theory of Coping [23], Beaudry and Pinsonneault [10] state that to cope with disruptive IT event IT users employ two processes. The first process is an evaluation in which people assess the importance of the event given their situation and interests. The second process is the copying process. In order to cope, users attempt to manage the situation [23]. The authors called this a "coping effort." Applied to IS, CMUA's user adaptation approach can enrich the view of individual IT reactions and go beyond several limitations in the literature on acceptance and usage of IS.

B. Related work on HIS Adaptation

HIS are information systems implemented to provide convenient and efficient healthcare services to patients in hospitals. HIS in hospitals are used for the following main reasons: save the time and the effort of the hospital's employees, as well as keep patient records safe and accessible. HIS adaptation goes back as early as 1985 – where a German hospital first adapted it [24This system, called "HELP, "is an advanced hospital information system developed at Salt Lake City 's Latter-Day-Saints Hospital. As a system that included a data-driven medical decision-making system, it was the first in the hospital's communication processes.

Another example of HIS adaptation is Veterans Information Systems and Technology Architecture (VISTA)[25], which has been developed and deployed throughout the United States by the US Department of Veterans Affairs (VA) at more than 1200 Veterans Health Administration (VHA) health sites and manages the largest integrated healthcare network in the US. VISTA consists of almost 180 clinical, financial, and administrative and infrastructure modules that need to be integrated into a single shared database, enabling all modules to share a single authoritative data source for all related services and care. VISTA was adopted globally and is considered to be adapted in healthcare institutions such as the World Health Organization [26].

Nonetheless, in recent years, the cost of providing high-quality services in hospitals has increased tremendously [27]. Hospital management found the solution to decrease cost, increase patient satisfaction, to improve hospital processes and to provide high-quality patient care is information systems in healthcare. The health care industry has witnessed a revolution in most developing countries because of information technology, where the role of digital technology in medical care and its delivery has expanded at an ever-increasing pace. Article [27] implemented an upgraded HIS into an existing computerized system and shared their experience with this implementation. The consequences of adapting multiple software modules specific to different clinical and special purpose applications and the need to consider the compatibility of information technology (IT) at the very outset have been highlighted. Productivity, cost, effectiveness, and many other benefits may never be realized if technology adaptation in healthcare terms are not open to future needs through HIS systems adaptation [27].

During the establishment and promotion of the health information system, the health sector of developing societies faces many barriers. These obstacles include lack of infrastructure, costs, technical sophistication, lack of qualified personnel and medical professionals. A survey conducted in [2] identified and categorized health information technology adaptation barriers. It also recognized that the existing health system should be considered for transformation by adapting successful systems to improve the population's health status.

Many hospitals are no longer developing in-house HIS solutions [28]. The method used in the health sector is based mainly on the purchase of software on the market. For many countries, this is problematic for two main reasons. First, financial resources for obtaining commercial hospital information systems (HIS) are not available. Secondly, they do not have similar cultural and organizational aspects that are implemented as part of commercial solutions from Western or developed countries implicitly or explicitly, where these applications have been developed, tested and implemented.

A layered approach based on an application framework and rapid application development (RAD) for system evolution and adaptation is proposed to address the problem

of health information systems alignment with healthcare processes-a major challenge in healthcare organizations [29]. It calls for the development of a demand-based system by integrating the software engineering process into business process optimization projects. They ensure that their working practices are also improved by closely involving end users.

Heeks concluded in [30] that the key success factors in HIS adaptation are the incorporation of the key technical, social and organizational aspects in which they are implemented. Heeks also stated that the failures are mainly due to system adaptation approaches that do not consider the entire context or cultural behavior [30]. Hence, this study is looking into cultural behavior properties that have an impact on the adaptation of HIS for the KSA environment.

The following parts describe the research methodology, which covers mainly on the Requirements Engineering (RE) process that are inception, elicitation, elaboration, validation, and management [31]. It is worth to note here that the main work's focus is broader, and we only focus on the RE process for this paper. Each of the activities is elaborated in the following subsequent subsections. After inception and elicitation, the results of the processes were further elaborated. Hence, this process onwards will be presented in the following section.

C. Requirements Inception

The aim of this initial phase is to determine the fundamental understanding of the problem and the nature of the solution. After investigating on adaptation and related work on HIS adaptation, the stakeholders have identified, i.e. hospital management, nurses, administrators, and registration clerks. The information is crucial to facilitate multiple viewpoints and to avoid any missing requirements from different viewpoints.

D. Requirements Elicitation

Requirements elicitation activity was conducted using two techniques that are (i) stakeholder-driven, i.e. focus group and interview; and (ii) document-driven, i.e. the existing HIS and its documentation [32]. The following sub-sections will elaborate on the elicitation process.

1) Stakeholder-driven: Based on Lamsweerde [32], stakeholder-driven techniques depend on communication with stakeholders to get adequate information on the domain, organization, and existing problems. In this research, the focus group and interviews were executed to fulfill this criterion. The following subsections introduce the participant background and the focus group session. The requirements elicitation was conducted from the focus group sessions and discussions with Riyadh Hospital analysis and developer teams, stakeholders' representative, and South Korea's (SK's) development team. The research participants were categorized into three categories. Riyadh Hospital employees whereby employees from different departments had participated in this research that are:

- The group of Application analysts and senior programmer analysts from the "System Development and Implementation" Unit and the researchers.
- Project Managers from "Technical Project Management Operation" Unit (t-PMO).
- The group of Application analysts and senior programmer analysts from the "Medical Information System" Unit from Riyadh region.
- Super users, i.e. administrators from each medical department.

South Korea (SK) employees whereby different employees from different teams in the SK's company had participated in this research that are:

- Senior analysts for each module in the system.
- Senior developers for each module in the system.
- Project managers.
- Database administrators.
- Translators.

University experts who observed evaluated and provided feedback for evaluation purpose.

The focus groups sessions were conducted in a conference room, where each session consisted of 4 to 8 participants depending on the session subject. Each session was audio-recorded and then transcribed to minutes of the meeting to be reviewed by the participants. At the start of each session, one of the participants (the inviter) introduced the main session subject, things to be discussed in the session and the outcomes they had hope to achieve. The focus group sessions were iterative sessions with each enhancement and each launching of one of the system's modules. However, as a kick-off of the system for the first time in the hospital it took almost two months to set the roadmap and identify the main requirements.

During these sessions, the questions were answered (see Table 1), and any points are waiting for any actions from the last session were followed. Furthermore, some system workflows were deliberated to enhance the system. Any preparation for upcoming implementation was also discussed. At the end of the session, a summary of the agreed points was presented. The inviter suggested for an arrangement of another follow-up session if further points need to be discussed. Finally, all participants were acknowledged for their work and participation.

TABLE I
FOCUS GROUP QUESTIONS

Engagement Questions	What is the briefed speaking language?
	The most clinics visited by patients?
	What kind of issues faced in your hospital?
	What is your vision for the hospital?
	How is your most competitive hospital?
Exploring Questions	What are your country rules and regulations?
	What are the main modules in the system you which to focus on?
	What kind of servers you have?
	What is the kind of patients treated in the hospital?
	Do you have special patients?
	Do you have specific room arrangements for specific patients?

Exit Questions	What is your hospital structure?
	Discussing specific workflows
	What is a future enhancement?
	When will we conduct the next session?

2) Artefact-driven: In addition to the stakeholder-driven techniques, artifact-driven techniques were also being adopted in this work. As such, another source of data collection for requirements elicitation is via the existing HIS and its related documentation. Through the user manual and the implemented user interface documentation, the research investigated cultural features and behaviors that might have any impact on the HIS adaptation. Furthermore, a qualitative assessment of experts' evaluation on the usefulness of the cultural feature model was also performed during the systems user interface adaptation tasks.

III. Results and Discussion

Based on the inception and elicitation processes, the results were analyzed and represented using analysis models. The following subsections elaborated on these processes:

A. Requirements Elaboration

During this stage, KSA culture and its environment were investigated and analyzed. At the commencement of this task, there were some issues, which were not considered by the SK team when the customized system was developed. If a software system has the potential to be used globally, the possible effects and customizations according to the requirements of the system should also be considered.

Based on the analysis of the elicitation process, the following requirements (including constraints and rules) specific to Saudi culture that were not considered are:

- The Saudi religion, i.e. Islam allows polygamy, i.e. men are allowed to have more than one wives.
- Any procedure that involves a female patient requires the consent from a male guardian even though the female patient is beyond the legal age.
- A female patient cannot follow-up in In Vitro Fertilization (IVF) clinics if she is not married at the beginning of the treatment.
- A female patient cannot start any follow-up with Obstetrics-Gynecology (OB/GYN) clinic for the pregnancy progress without the consent of their male guardian.
- The patient chart should not show the female picture, concerning their religion.

IEEE Computer Society [33] defines a requirement as "(1) a condition or capability needed by a user to solve a problem or achieve an objective; (2) a condition or capability that must be met or possessed by a system or system component to satisfy a contract, standard, specification, or other formally imposed documents; and (3) a documented representation of a condition or capability as in (1) or (2)". The general requirement classification is (1) functional requirements, (2) quality requirements, and (3) constraints [34]. For this work, we opted for using the requirements category as functional requirements, quality requirements and business rules. We considered business rules that need to be referred to when implementing the relevant requirements. The elicited requirements were then being classified based on this category. See Table 2.

TABLE II
Classification of Requirements

No	Requirements	Description: Functional (F), Quality Requirements (QR), Business Rule(R)
1	The female patient picture must not be shown.	R
2	Single female patients cannot start treatment in IVF clinics.	R
3	Any female patient must require a male guardian.	R
4	Patient must be eligible.	R
5	A patient under the legal age must require a male guardian.	R
6	The female patient needs the consent of her male guardian.	R
7	The information on the husband is mandatory.	F
8	The information of the wife(s) is optional.	F
9	Patient with eligibility is treated for free.	R
10	Patient in critical condition must be treated for free.	R

In addition to the above requirements, some other cultural elements were also being gathered during the elicitation process. Among them are main language used [35], reading/writing direction i.e. right-to-left or left-to-right [36], and religion [37]. These cultural elements have been presented in [4] and will not be discussed further in this paper.

1) Analyzing the Requirements of Riyadh HIS

The HIS features that are covered in this study could be categorized into four main modules that are: (1) User Management Module, (2) Electronic Medical Record (EMR) Module, (3) Nutrition Module, and (4) Patient Services Module. This first module is under supportive care, which is the first interaction step for the patient in HIS. This is when

the patient will be registered through the patient registration feature. We analyzed the types of patients for Riyadh HIS including Government Employee and their related family, Royal family, emergency, married, female and underage.

The EMR module is under the responsibility of direct care, and it contains several functionalities that are New Patient Admission, Flow Chart, and Patient Appointment Scheduling. The focus of this study will be on patient admission and appointment scheduling. Admission information and accessibility of the information for each of the category of the patients were also being investigated. For instance, the medical information of the royal patient could not be accessible by any staff in the hospital except for the pre-assigned group of medical staff. Also, admission eligibility of the patient type was also being analyzed.

The subsequent module, i.e. Nutrition Module is under supportive care, which applies to patients' health needs. In this module, the timing of patients' meals shall be considered when it involves fasting period, i.e. they need to receive their first meal after Maghreb prayer and their last meal of the day before Fajr (morning) prayer. Moreover, cultural preferences also need to be considered for selecting a meal for admitted patients. Finally, the Patient Services Module covers the maintenance of hospital assets, such as room and ward management.

During this stage, requirements were analyzed and represented in models. Here, we used a use case diagram, which represents the main features of the system, its actors and their interactions [38]. Figure 1 depicts the use case diagram for the HIS.

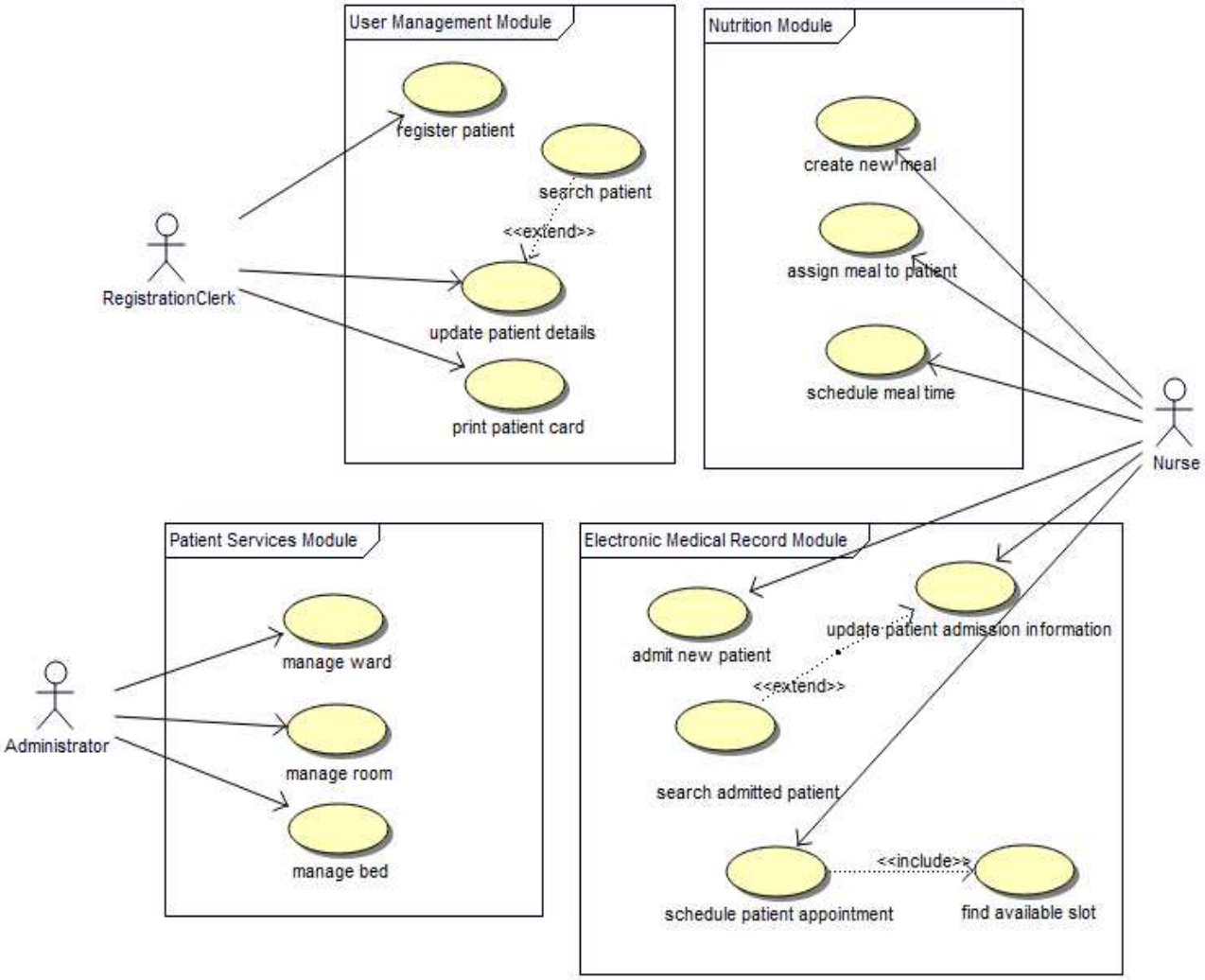

Fig. 1 Use Case Diagram for HIS

User Management Module is the first interaction step for the patient in the South Korean HIS system, where the patient will be registered to the system. Nutrition Module is used to record patients meals applicable to their health needs as recommended by medical doctors. Electronic Medical Record Module contains several functionalities that are New Patient Admission, Flow Chart, and Patient Appointment Scheduling. In this section, the focus will be on patient admission and appointment scheduling. Finally, Patient Services is responsible for maintaining the hospital assets, such as the room and ward management. It is managed by supportive care.

Also, the use case diagram, to capture the structural view of the system, we represented the relevant details into a class

diagram. A class diagram represents the classes and its' properties and the relationships between classes [38]. This diagram is used as a reference and also being refined during design. Due to space constraint, we did not include the diagram here.

For each use case, an activity diagram was created to represent the flow of the use case scenario. Here, we provide an activity diagram that was derived to represent the patient registration workflow. See Figure 2.

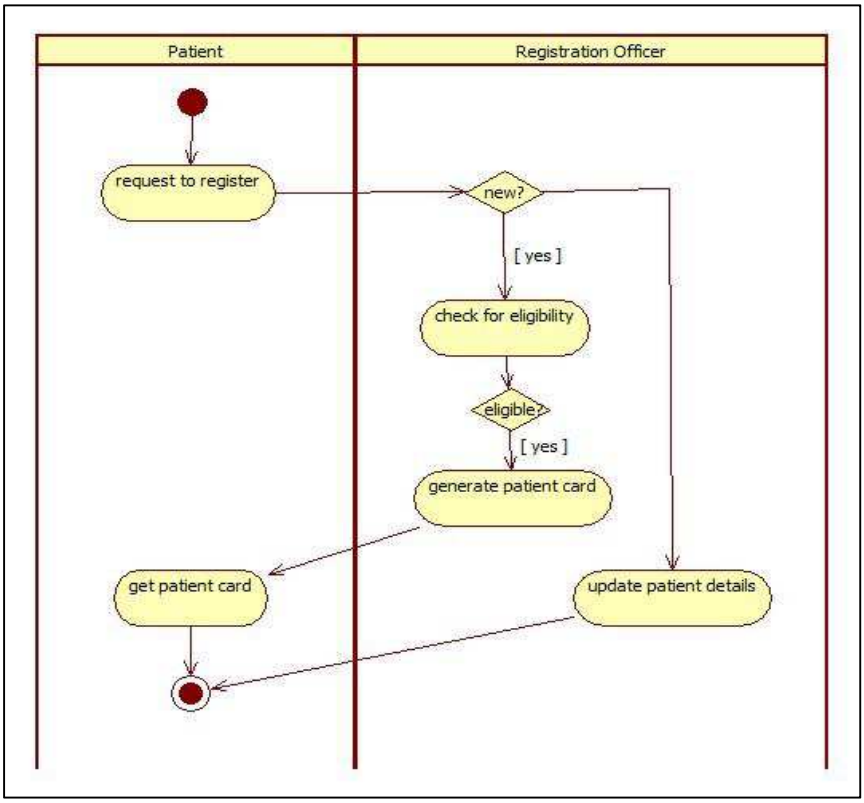

Fig. 2 Activity Diagram for Register Patient Workflow

As shown in the diagram, when a new patient requested to register to the hospital, the registration officer will first check the patient's eligibility. If the patient is eligible, the officer will register the patient and create the patient card with the required details such as family, guardian and spouse details. During this stage, a classification of HIS user is derived. Altogether six categories of users were identified. For each of this category, a description and its related user category are provided.

TABLE III
HIS USER CLASSIFICATION

No	ID	User Classification	Description	Related ID
1.	USR01	Government Employee and their related family	Any employee belong to this government facility will be considered as a patient in this hospital, and they can register their related family (husband, wife, mother, father, son, or daughter) as patients in this hospital.	-
2.	USR02	Royal family	Some of the royal family members will be considered as a patient in this hospital, regardless of where they are employees in this government facility or not.	USR01
3.	USR03	Emergency Patient	The hospital could register patients, who are not an employee in the government facility, related family of the government employee, or a royal family. In this case, it is an emergency patient and needs critical care, where they come through the emergency room. The hospital is responsible for treating those patients.	USR01, USR02
4.	USR04	Married Patient	In the case of registering a female, married patient, she needs to provide the spouse information. This information is not needed in the case of a married male patient. He needs to provide emergency information only (mobile number of an emergency person to contact).	USR01
5.	USR05	Female Patient	Any female patient is required to provide male guardian information, who will be accountable in approving medical procedures.	USR01

6.	USR06	Under 18 years old	Patients who are under 18 years need to provide male guardian information that will need to approve any medical procedures that may be performed on the patient.	USR01

2) Mapping of the Requirements of Riyadh HIS to Its Potential Impact

The research investigates Saudi Arabia cultural and environmental features as an attempt to adapt the existing SK HIS. As a result, the environmental and cultural features are grouped into 4 HIS modules. See Table 4. The table provides the mapping of each of the requirement to the potential impact and the relevant use cases. Based on this list, developers could refer to the potential impact when specifying requirements for adaptation and could also be useful in later stages such as design and testing.

For instance, when the information of the spouse (husband) is mandatory, this requirement impacts the registration patient, update patient details, admission of a new patient and also update admitted patient information. The use case specification for relevant use cases will be updated.

B. Requirements Validation

The requirements were validated by a requirement review session, which was attended by the group of application analysts and senior programmer analysts from the System Development and Implementation unit and the researchers, project managers from t-PMO unit, the group of application analysts and senior programmer analysts from Medical Information System Unit from Riyadh region, administrators, and also academic experts.

The outcome of the requirements review is then validated by expert evaluation. There were three experts involved in the evaluation. The experts have experiences in the fields of software engineering (SE) and human-computer interaction (HCI) evaluation. The experts are all Ph.D. holders from the Computer & Information Sciences and Software Engineering department at Prince Sultan University (PSU).

TABLE IV
MAPPING OF REQUIREMENTS AND ITS POTENTIAL IMPACT

Requirements/Rules	**Potential Impact**	**Use Case (see legend)**
1 The female patient picture must not be shown.	Display of patient picture feature should only apply to male patients.	[1], [2], [3], [4], [5], [7]
2 Single female patients cannot start treatment in IVF clinics.	Creating new IVF treatment appointment feature should only cater to couples.	[1], [2]
3 Any female patient must require a male guardian.	Register patient feature should include male guardian information in the patient profile.	[1], [2], [5]
4 Patient must be eligible.	Register patient feature should include eligibility type and eligibility expiration date for the patient in the patient profile.	[1], [2], [5]
5 A patient under the legal age must require a male guardian.	Register patient feature should include male guardian information in the patient profile.	[1], [2], [5]
6 The female patient needs the consent of her male guardian.	For the female patient, any procedure that needs consent cannot proceed without male guardian consent.	[1], [2], [5], [9]
7 The information on the husband is mandatory.	The patient profile shall only be allowed to be saved when providing the spouse/husband information.	[1], [2], [5], [6]
8 The information of the wife(s) is optional.	The patient profile shall be saved with/without providing the spouse/wife information. The patient profile shall allow a male patient to add up to four wife(s) information.	[1], [2], [5], [6]
9 Patient with eligibility are treated for free.	The billing feature should be set as free for eligible patients.	[2], [8]
10 Patient in critical condition must be treated for free.	The billing feature should set free for critical condition patients.	[1], [2], [5], [8]

Legend: 1- Register Patient, 2- Update Patient Details, 3- Print Patient Card, 4-Search Patient, 5-Admit New Patient, 6- Update Admitted Patient Information, 7- Search Admitted Patient, 8-Billing (Billing module is beyond the scope of this work; however, the requirement has a potential impact on the module), 9-Schedule Appointment

The experts reviewed the potential cultural and environmental issue which may have an impact on the adaptation of the HIS (See Table 2). After completion of the evaluation, the experts aggregated all the evaluation, feedback and communicated the outcomes. Based on the expert's feedback, all the listed items are relevant and could potentially be useful in the adaptation of HIS. This procedure is essential to ensure objective and unbiased evaluations. The results of the evaluation were reported as written statements.

This study illustrated the cultural behavior needs in the context of religion, language, and nationality. Since the source system was developed in a foreign country, and most of the population are Christian or Buddhism, these differences had led to a substantial cultural gap between the two countries, such as the Saudi Arabian cultural restriction does not allow a picture of the female patient to be stored

and seen in a system that is not controlled and maintained by the government for the privacy of their citizens, and the system was not supporting the Arabic language and layout. Moreover, Islam religion allows a male to have more than one wife, and this logic was not configured in the system as a start.

We had elicited, analyzed and mapped the cultural behavior features, which potentially could give an impact to the KSA system adaptation. If the cultural behavioral requirements are not incorporated into implementation, this might lead to ineffectiveness of the relevant business process and low user satisfaction.

In addition to that, it is worth to note that one of the limitations of this study is lack of access to the HIS system to explore the original HIS, where some cultural features could be analyzed and potentially be recommended to be enhanced. Moreover, the confidentiality agreement with the hospital management limits the scope to explore for more detailed information about the system, and it is implementation.

IV. Conclusion

In this paper, we presented the RE process in the KSA system adaptation from the SK system. The SK system needed to be analyzed of any mismatch requirements due to culture behavioral issues as the system was initially developed for South Korean hospitals. We approached this study from the perspective of RE and pointed out some cultural, behavioral properties.

A potential future work is to consider extending and developing cultural behavior features like a reusable component. By doing so, it could potentially be applied to the system adaptation from the perspective of design-with reuse facet. This will not only benefit a specific culture and environment, but also could be adopted in any application domain, and not only specific to HIS.

Acknowledgment

This research is part of work in [1] and [4], which is also sponsored by the Human-Computer Interaction (HCI) Research Group; Prince Sultan University (PSU), Riyadh, Saudi Arabia [RG-CCIS-2017-06-01] and Research Initiative Grant Scheme (RIGS) [RIGS16-344-0508], International Islamic University Malaysia (IIUM).

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